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Commanding Officer Decision Superiority: The Role of Technology and the Decision Maker

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SSC Pacific … on Point and at the Center of C4ISR

US Airways Flight 1549 January 2009

"Unable. We're going to be in the Hudson."

"I knew from the sound that the engines were making and from the vibration I felt and from the smell of the birds, I knew that we had damaged both engines severely."

"I needed the wings exactly level at touchdown. I needed to make the rate of descent survivable. I needed to touch down at nose-up attitude. And I needed to touch down just above our minimum flying speed. And all those needed to occur simultaneously."

- Experience, knowledge, intuition, adaptability

USS PORT ROYAL February 2009

- CG 73 grounded off coast of Oahu
- Capabilities
  - "Most advanced warship"
  - AEGIS weapons systems - the only fully integrated electronic detection, engagement and fire control system in the world today
  - Original Navy Area Theater Missile Defense - BMD

"The PORT ROYAL is one of the Navy's premier warships, equipped with the sophisticated Aegis radar system and capable of shooting down enemy ballistic missiles."

….yet, grounded in 17-22 ft water when minimum should have been 32 ft

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Agenda

- Situation awareness systems
- Technology-based solutions
- Decision maker-based solutions
- Warfighter-technology symbiosis
- Incredibly complex tasks
- Artful competence
- Training implications
- Summary

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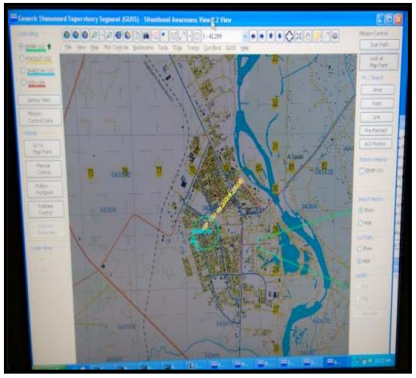
Situational Awareness



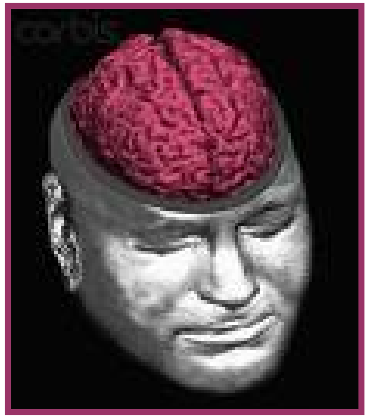
"…strictly defined, situational awareness refers to the degree of accuracy with which one's perception of the current environment mirrors reality."

M.N. Vego

Joint Forces Quarterly

2009

Three Levels of Situational Awareness



"…the perception of elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future."

M.R. Endsley
Human Factors
1995

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Decision Superiority: Technology Solutions

- Navy is a technology-focused organization
- Develops “capabilities”

- Technology-based solutions to performance problems
  - New or improved displays
  - More information
  - Data fusion

- Embedded in an acquisition-based system

Decision Superiority: Technology Solutions

- Advantages
  - Quick
  - Less risky

- Limitations
  - Short term
  - Reactionary, ad-hoc
  - Addresses symptoms vice root cause
  - Information overload possible
  - Simplified displays may mask problem complexity

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Decision Superiority: Warfighter Solutions

"Decision-making involves judgment and no machine has yet to achieve this core skill to the level required to engage in the art of warfighting." (Ramsey, 2007)

- Technology does not address underlying root cause
- Acquisition, personnel selection, training, and assignment systems not aligned
- DOTMLPF

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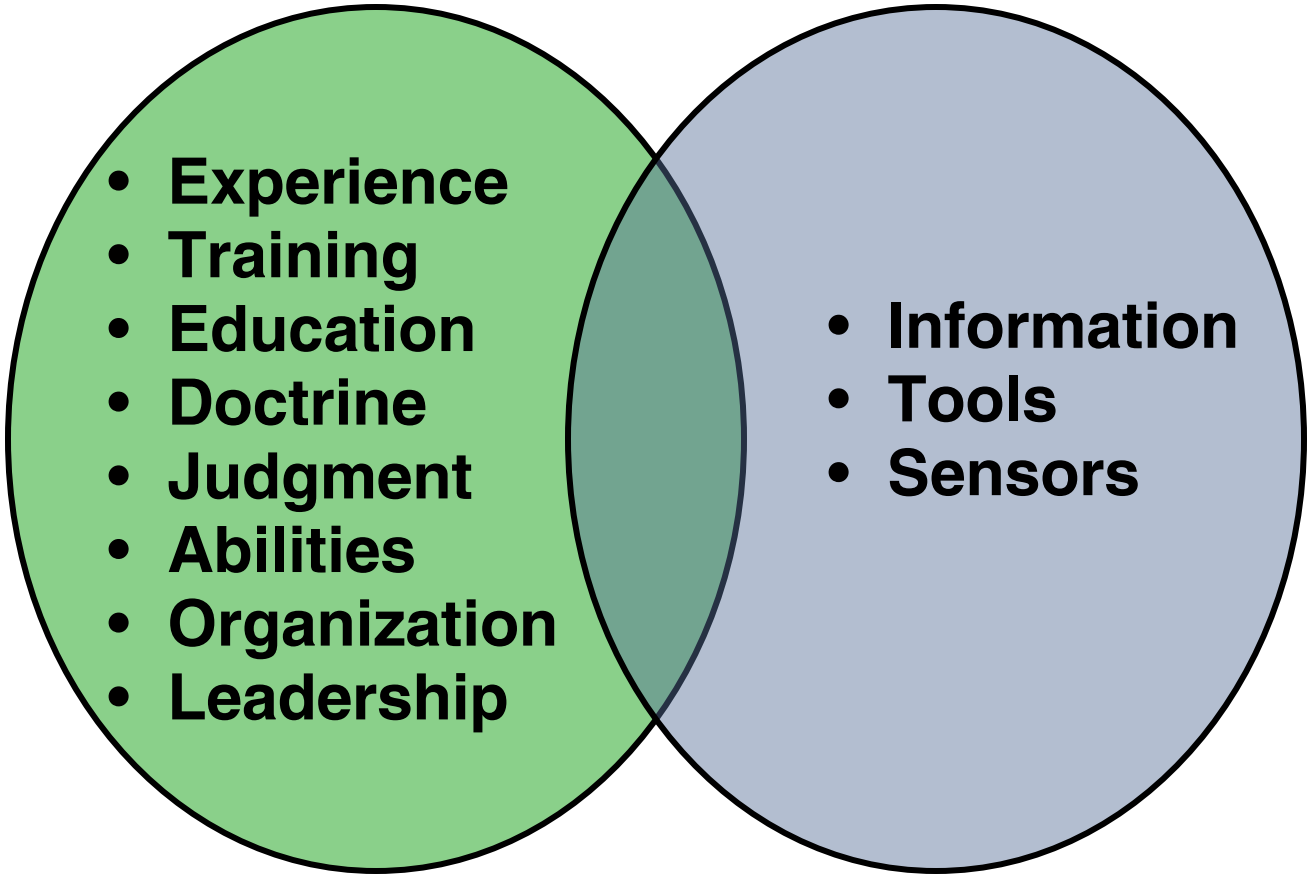
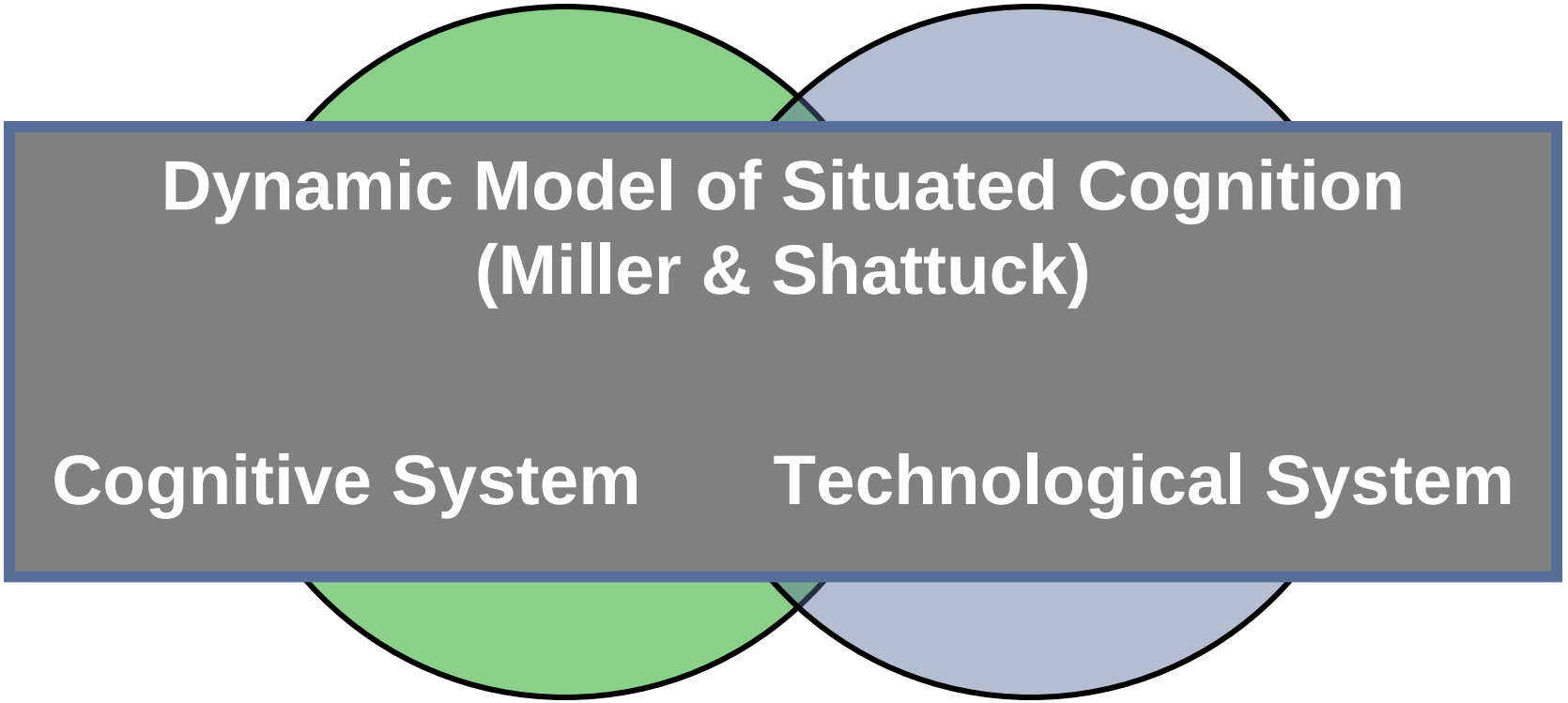
Warfighter – Technology Symbiosis



Warfighter – Technology Symbiosis



Incredibly Complex Tasks

- 85% of military tasks are procedural or declarative
  - Can be handled by standard training technologies and job aids
- Remaining 15% of tasks are “incredibly complex”
- Complex tasks are abstract, multi-variate, non-linear, dynamic, interactive:
  - Occur across individuals and teams often not co-located
  - Occur at all levels of command
  - Consequences of poor individual or team performance can be catastrophic

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Examples of Incredibly Complex Tasks

Prepare campaign or major operations and related plans and orders.
Evaluate the physical and civil (political, cultural, and economic) environments of the battlespace in order to identify the impact of environment on both friendly and enemy forces.
Determine the military implications of fused intelligence indicators, all source information, and orders of battle.
Establish a plan for water space management and the prevention of mutual interference.
Conduct deception in support of tactical operations.
Maintain cultural awareness.

- Joint Staff, Universal Joint Task List, CJCSM 3500.4D, 1 Aug 2005 Change 1. Approved 15 Sep 2006.
- OPNAVINST 3500.38B/MCO3500.26/USCG COMDTINST M3500.01B Universal Naval Task List, 30 January 2007, DRAFT CHANGE ONE 15 JAN 2008

Artful Competence

- Revealed in what a person does
- Demonstrating superior performance by handling complexity, instability, and conflict when engaging people and situations (Schon, 1983)

Incredibly complex tasks require artful competence

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Artful Competence

SKILL	DEFINITION
Analytical	Deliberate, rational analysis
Intuitive	Knowing something without the use of rational processes
Creative	Cognitive flexibility; adapting to novel situations
Affective	Regulate emotion or arousal either consciously or unconsciously

Artful Competence

- Striking a balance among these abilities and finding the right synthesis for the right situation, adapting to the situation

- Required skill configuration varies by situation
  - Flooding casualty
  - Weapon employment against hostile contact
  - Surface transit with restricted visibility

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Training Implications

- Deliberate practice
- Intuitive decision making requires the analytical side as a base; still need the tactical skills & knowledge
- Incredibly complex tasks require 10-20 years of experience to develop expertise
- Services must develop long term training programs to assure expert performance in these situations
- New research & development needed:
  - Development of training for expertise in complex tasks
  - Simulation for practice environments so that expertise can develop

Training Implications

"Navy must ensure its workforce is capabilities-based and competency-focused for a Total Force that is properly aligned from accessions through transition following service to our Navy. Through delivery of Sea Warrior, Navy training, education and career management systems will effectively provide for the growth & development of Navy people."

Admiral Mike Mullen
Navy Strategic Plan

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Summary

- Material solutions
  - No more control room displays!
- Capability-driven workforce
- DOTMLPF solutions
  - Requires more effort and resources initially
  - But, long term benefits unparalleled and long term
- Ideal world
  - Align professional training, selection, evaluation, and experience....
    ….and technology!

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Discussion and Questions

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Back Ups

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Characteristics of Incredibly Complex Tasks

Abstract	**Physical phenomena or causation are not readily visible.**
Multi-variate	**Many variables underlie outcomes.**
Interactive	**Changes in one variable may affect several others. Processes are co-dependent.**
Continuous	**Physical phenomena and their effects are described as values along continua, rather than as discrete properties.**
Non-Linear	**Relations among variables are not simple straight-line functions.**
Dynamic	**The process of variation is of interest, rather than end-state.**
Simultaneous	**Systemic variation is coincident rather than serial.**
Conditional	**Outcomes are highly dependent on boundary conditions and context.**
Uncertain	**Exact values of underlying variables are not known precisely – they may be estimates, interpolations, approximations.**
Ambiguous	**The same outcome may arise from different combinations of inputs.**

Artful Competence Origins

- Professional development
  - Training and education
    - Quality vs. quantity
    - JO training vs. senior officer skills
    - Deliberate practice
    - Reflection
- Experience
  - Breadth: variety of assignments & positions
  - Depth: time spent in assignments & positions
- Motivation
- Innate capabilities?

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Training for Expertise

Experts know a lot. Expert knowledge is highly contextual.	Training must provide increasingly detailed knowledge, procedures, principles, in context, with progressive refinement as expertise develops.
Expert knowledge is structured.	Provide suitable knowledge structures early in training.
Expert knowledge / skill is compiled and proceduralized.	Provide sufficient practice for experience to be compiled.
Experts tend to work forward from underlying principles rather than backward from the end goal.	Provide underlying principles as part of the knowledge structures. Do NOT provide unstructured end-goal exercises until principles have been learned.
Experts examine a broad range of alternatives rather than explore a single alternative deeply.	Practice environment must provide for many alternatives and must model them correctly.
Expertise takes a long time to develop: 10+ years of deliberate practice.	Develop training programs which are 10+ years long. The practice environment must provide high-levels of fidelity to support expert-level decision making in context.
Expertise keeps developing even after many years and thousands of opportunities for practice.	Provide expert-level practice environments through simulation and carefully designed exercises.

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Instructional Design for Incredibly Complicated Tasks

Abstract	**Develop visualizations that explain physical phenomena and causation**
Multi-variate	**Develop simulation-based/physics-based problem space in which effects of variation can be explored**
Continuous	**Do NOT use discrete or static cases for training. Provide practice for continuous variation.**
Non-Linear	**Explore the non-linearity: provide practice that concentrates on inflection points, minima, maxima, zero-crossings, asymptotes**
Dynamic	**Practice environment must include dynamic complexity – Scenarios must present continuous evolution.**
Interactive	**For high-way interactions, systematically hold some variables constant while exploring variation. Use no more than three-way interactions for problem cases.**
Simultaneous	**Develop mental model for simultaneity as underlying interaction, not serial causation.**
Conditional	**Provide highly contextualized practice environment which is capable of supporting practice in high-difficulty real-world warfare environments.**
Uncertainty & Ambiguity	**Teach methods / procedures for resolving uncertainty / ambiguity. Practice environment must properly replicate these effects. Develop test scenarios which exploit uncertainty.**

(Feltovich, Spiro, & Coulsen, 1991; Feltovich et al, 2004, Wulfeck & Wetzel-Smith, 2007)